High Energy Background at SNO

A. W. P. Poon, A. D. Marino, Y. D. Chan, X. Chen, K. T. Lesko, E. B. Norman, C. E. Okada, and R. G. Stokstad

In the extraction of the solar neutrino signal from the SNO detector, there are several high-energy backgrounds that one must consider. These backgrounds include muon-induced spallation products, neutrons and γ rays from the cavity wall, α-induced γ rays from the PMT components and from the PMT Support geodesic (PSUP). Muon-induced events can be easily removed by putting a veto time window following the muon. In this article, we will describe the characteristics of the other classes of high-energy backgrounds and how their event rates in the SNO detector can be extracted.

One of the difficulties in extracting the high energy background rate in the neutrino data is to identify these events. One would expect these backgrounds, whether it is γ ray from the cavity wall or the PSUP, to be inward-going. In other words, $\hat{u} \cdot \hat{R}_{fit}<0$, where $\hat{u}$ and $\vec{R}_{fit}$ are the fitted direction and vertex of the event. Figure 1 shows the $\hat{u} \cdot \hat{R}_{fit}$ distribution as a function of $(R_{fit}/R_{AV})^3$, where R_{AV} is the radius of the acrylic vessel (=600 cm), for events with $\mathrm{N}_{hits}\geq 40$. In this plot, it is clear that the $\hat{u} \cdot \hat{R}_{fit}$ distribution is fairly uniform in the D_2O region. There is an increased event rate where $R_{fit}>6$ m. These are the high-energy tail of $\beta\gamma$ backgrounds and the high energy background. As R_{fit} increases, there are more inward-going ($\hat{u} \cdot \hat{R}_{fit}<0$) events. When we restrict to events that are reconstructed to the H_2O region ($600<R_{fit}<900$ cm), the $\hat{u} \cdot \hat{R}_{fit}$ distribution is very sharply peaked near -1 after eliminating the low energy background by placing a N_{hits} cut. In the H_2O, the $\cos\theta$ distribution, where θ is the polar angle in the PSUP coordinate system, shows highest count rates near the equator of the detector ($\cos\theta \sim 0$). These events are γ rays from the cavity wall as these γ rays have the shortest path length to traverse near the equator. The external γ ray distribution is found to be sitting on a flat distribution. These are the high energy γ ray from the PSUP.

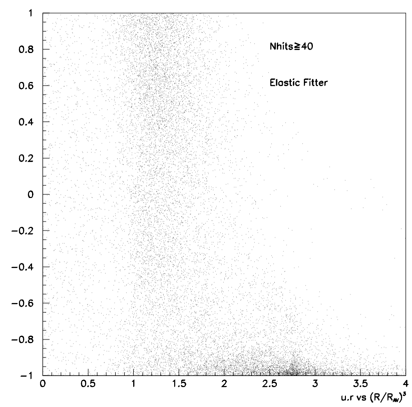

Figure 1: $\hat{u} \cdot \hat{R}_{fit}$ versus $(R_{fit}/R_{AV})^3$ for events with $\mathrm{N}_{hits}\geq 40$.

One can estimate the high energy background rate from these external γ rays in the D_2O fiducial volume using the ^{16}N calibration data taken at large radial distances in the H_2O. If we assume that the fitters reconstruct the high energy background events with the same efficiencies as the ^{16}N events in the H_2O, then the number of high energy background events in the D_2O during solar neutrino data taking is εN_{ν}, where ε is the ratio between the number of ^{16}N calibration events that are reconstructed to within the D_2O to that for a monitoring window Ω in the H_2O, and N_{ν} is the number of events in the neutrino data set that are reconstructed to within Ω.

This idea has been applied to the solar neutrino data set. Initial results show that the high energy background rate in the D_2O volume is much lower than the neutrino signal rate. More quantitative results will be released in the near future.